

## Claims

[ 1]     A method for producing a substrate having a carbon-doped titanium oxide layer, characterized by directly striking a combustion flame of a gas consisting essentially of a hydrocarbon, against a surface of a substrate having at least a surface layer comprising titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide, to heat-treat the surface of the substrate such that a surface temperature of the substrate is 900 to 1,500°C; or by heat-treating the surface of the substrate in a combustion gas atmosphere of a gas consisting essentially of a hydrocarbon such that the surface temperature of the substrate is 900 to 1,500°C, thereby forming a carbon-doped titanium oxide layer.

[ 2]     A method for producing a substrate having a carbon-doped titanium oxide layer, characterized by heat-treating a surface of a substrate, which has at least a surface layer comprising titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide, in a gas atmosphere consisting essentially of a hydrocarbon such that a surface temperature of the substrate is 900 to 1,500°C, thereby forming a carbon-doped titanium oxide layer.

[ 3]     The method for producing a substrate having a carbon-doped titanium oxide layer according to claim 1 or 2, characterized in that the substrate, which has at least a surface layer comprising titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide, is composed, as a whole, of one of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide.

[ 4]     The method for producing a substrate having a carbon-doped titanium oxide layer according to claim 1, 2 or 3, characterized in that the substrate, which has at least a surface layer comprising titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide, is composed of a surface portion forming layer and a core material, and materials for the surface portion forming layer and the core material are different.

[ 5]     The method for producing a substrate having a carbon-doped titanium oxide layer according to any one of claims 1 to 4, characterized in that the substrate, which has at least a surface layer comprising titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide, is powdery.

[ 6]     The method for producing a substrate having a carbon-doped titanium oxide layer according to any one

of claims 1 to 5, characterized in that the titanium alloy is Ti-6Al-4V, Ti-6Al-6V-2Sn, Ti-6Al-2Sn-4Zr-6Mo, Ti-10V-2Fe-3Al, Ti-7Al-4Mo, Ti-5Al-2.5Sn, Ti-6Al-5Zr-0.5Mo-0.2Si, Ti-5.5Al-3.5Sn-3Zr-0.3Mo-1Nb-0.3Si, Ti-8Al-1Mo-1V, Ti-6Al-2Sn-4Zr-2Mo, Ti-5Al-2Sn-2Zr-4Mo-4Cr, Ti-11.5Mo-6Zr-4.5Sn, Ti-15V-3Cr-3Al-3Sn, Ti-15Mo-5Zr-3Al, Ti-15Mo-5Zr, or Ti-13V-11Cr-3Al.

[ 7]      The method for producing a substrate having a carbon-doped titanium oxide layer according to any one of claims 1 to 6, characterized in that the gas consisting essentially of a hydrocarbon contains 30% or more by volume of an unsaturated hydrocarbon.

[ 8]      The method for producing a substrate having a carbon-doped titanium oxide layer according to any one of claims 1 to 7, characterized in that the gas consisting essentially of a hydrocarbon contains 50% or more by volume of acetylene.

[ 9]      The method for producing a substrate having a carbon-doped titanium oxide layer according to any one of claims 1 to 8, characterized by forming the carbon-doped titanium oxide layer containing 0.3 to 15 at% of carbon.

[ 10]     The method for producing a substrate having a carbon-doped titanium oxide layer according to any one of claims 1 to 9, characterized by forming the carbon-doped titanium oxide layer having Vickers hardness of 300 or higher.

[ 11]     The method for producing a substrate having a carbon-doped titanium oxide layer according to claim 10, characterized by forming the carbon-doped titanium oxide layer having Vickers hardness of 1,000 or higher.

[ 12]     The method for producing a substrate having a carbon-doped titanium oxide layer according to any one of claims 1 to 11, characterized by forming the carbon-doped titanium oxide layer functioning as a visible light responding photocatalyst.